Perspective on Climate Change

Prepared by Bjørn Lomborg, adjunct professor at Copenhagen Consensus Center, Copenhagen Business School for the Subcommittee on Energy and Air Quality joint hearing with the Subcommittee on Energy and Environment of the Committee on Science and Technology on Wednesday March 21, 2007.

Introduction

Climate is back on the agenda, thanks to a large degree to my co-presenter, Al Gore. The climate discussion was strong in 1992 when it was put on the agenda by the Earth Summit in Rio and through the Kyoto Protocol agreed in 1997. Gore deserves applause for making global warming cool again.

However, in this presentation I will move beyond recognizing the importance of global warming and ask how we should view it, deal with it and put it in perspective.

I will make 4 basic points.

1. Global warming is real and man-made. This point has been made in many places, but perhaps most strongly and convincingly by the IPCC (2007a).
2. Statements about the strong, ominous and immediate consequences of global warming are often wildly exaggerated, as I will show below.
3. We need a stronger focus on smart solutions rather than excessive if well-intentioned efforts.
4. We need – as this hearing asks for – to put global warming in perspective. Climate change is not the only issue on the global agenda, and actually one of the issues where we can do the least good first.

Let us be frank. Al Gore and the many people he has inspired have good will and great intentions. However, he has got carried away and come to show only worst-case scenarios. This is unlikely to form the basis for a sound policy judgment. The problem is compounded in that if we follow Al Gore's recommendations, we will likely end up choosing very bad policies to solve the many problems, we agree need attention.

In short, following Gore's logic, with its good will and fine intentions, will actually end up costing millions of lives.[1]

Let me lay out the argument for you.

[1] Take malaria. Dealing with malaria by affecting a change in global warming through the Kyoto Protocol will probably save in the order of 0.1% of annual malaria deaths averaged over the century (289.5m/9109.5m * 7%/2 (Arnell et al., 2002:439; Wigley, 1998:2287) or save about 1,000 lives each year (at 1m deaths, (Awash & UN Millennium Project. Working Group on Malaria., 2005:1). In comparison, a targeted approach could cut malaria deaths by 75% or 750,000 per year averaged over the century. (Notice, because of growth in population and climate effects, the actual numbers would probably be about 1,400 and 850,000 on average over the century.) Moreover, the cost of Kyoto would be $180 billion annually, compared to just $3 billion annually for the targeted malaria policy (Awash & UN Millennium Project. Working Group on Malaria., 2005:2; Weyant & Hill, 1999). Kyoto would therefore save 140,000 people at 60 times the cost, whereas a targeted malaria policy would save more than 85 million. Not initiating the targeted malaria policy first means forgoing saving – or simply costing – 85 million lives.

Global warming is real and man-made

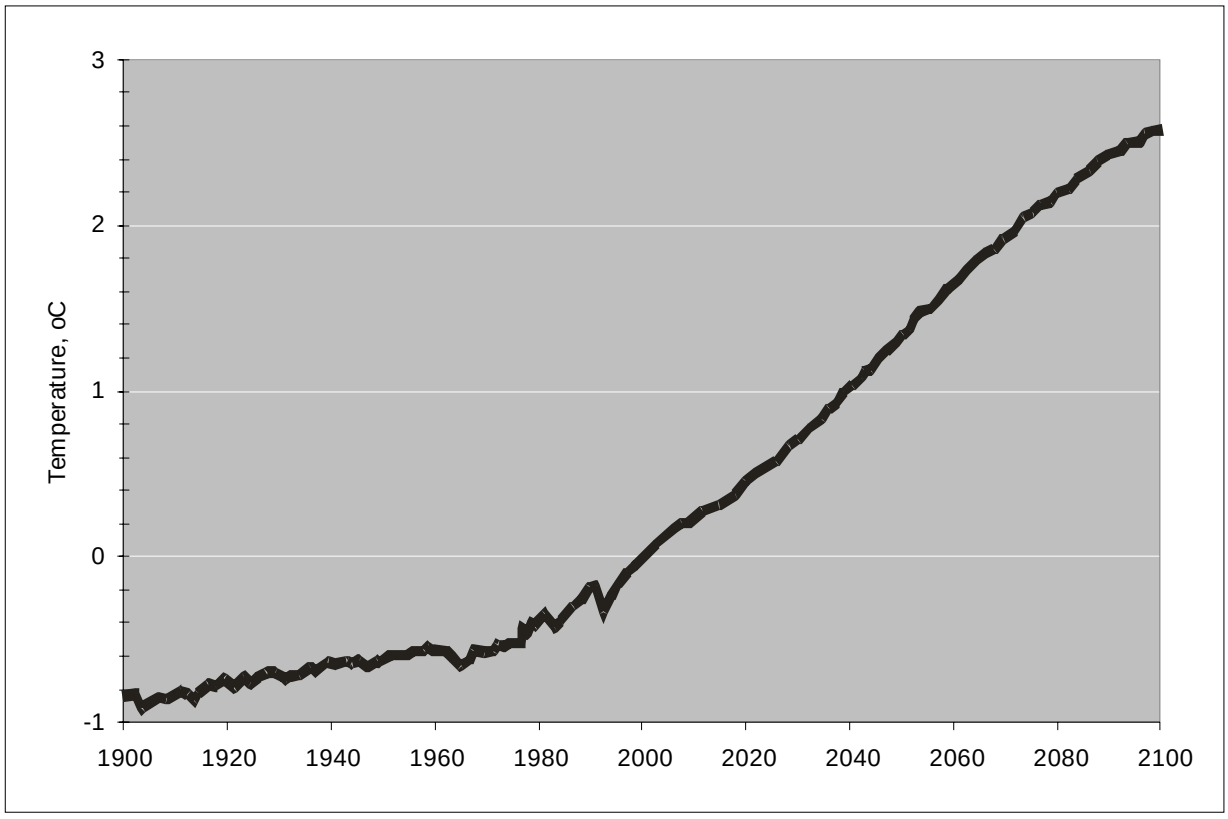

Figure 1 Expected temperature increase from 2000-2100 in the business-as-usual scenario (with simulation of temperature increase from 1900-2000).[2]

I would argue that our best information comes from the UN Climate Panel, the so-called IPCC (the Intergovernmental Panel on Climate Change). In Figure 1, we have a simple, standard prediction for the coming hundred years from the medium scenario of the 2007 IPCC report. Here we are told that that over the century global mean temperatures will increase about 2.6°C (4.7°F) with a span of 1.8-4.0°C[3]

The total cost of global warming is anything but trivial, about $15 trillion.[4] Yet it is only about 0.5% of the total net worth of the 21st century, about $3,000 trillion.[5]

Consequences often vastly exaggerated

Global warming is being described in everyday media in ever more dire terms. The IPPR think tank (which is strongly in favor of CO_2 cuts) in 2006 produced an analysis of the UK debate. It summarized the flavor thus:

> Climate change is most commonly constructed through the alarmist repertoire – as awesome, terrible, immense and beyond human control. This repertoire is seen everywhere

[2] (IPCC, 2007a:14; , 2007b:fig 10.3.1) of A1B, described as the Business-As-Usual scenario, (Dai, Wigley, Boville, Kiehl, & Buja, 2001).
[3] And a span of this from 1.1-6.4°C (IPCC, 2007a:13).
[4] Estimated from (Nordhaus, 2006a).
[5] The discounted GDP of A1B economic output from (Nakicenovic & IPCC WG III., 2000).

> and is used or drawn on from across the ideological spectrum, in broadsheets and tabloids, in popular magazines and in campaign literature from government initiatives and environmental groups. It is typified by an inflated or extreme lexicon, incorporating an urgent tone and cinematic codes. It employs a quasi-religious register of death and doom, and it uses language of acceleration and irreversibility.[6]

This kind of language makes any sensible policy dialogue about our global choices impossible. In public debates, the argument I hear most often is a variant of "if global warming is going to kill us all and lay waste to the world, this has to be our top priority – everything else you talk about, including HIV/AIDS, malnutrition, free trade, malaria, clean drinking water may be noble but utterly unimportant compared to global warming." Of course, if the deadly description of global warming were correct, the inference of its primacy would also be correct, but as we will see, global warming is nothing of the sort. It is one – but only one – problem of many, we will have to tackle through the 21st century.

Very clearly this is seen in the Gore's own description of his movie, *An Inconvenient Truth*. Here it is said that:

> We have just ten years to avert a major catastrophe that could send our entire planet into a tail-spin of epic destruction involving extreme weather, floods, droughts, epidemics and killer heat waves beyond anything we have ever experienced.[7]

Yet this is simply incorrect, both as it stands and in its policy conclusions. Let us look at heat deaths, sea level rise, hurricanes and malaria as outstanding examples of Gore's claim.

Heat and cold deaths

Very often, we only hear about the heat deaths but not the cold deaths – and sometimes this is even repeated in the official literature, as in the US 2005 Climate Change and Human Health Impacts report, where heat is mentioned 54 times and cold just once.[8] We need to know just how much more heat deaths we can expect compared to how many fewer cold deaths.

Much has been made of the heat wave in Europe in early August 2003, which killed 35,000 people, with 2,000 deaths in the UK.[9] Yet, each year more than 25,000 people die in the UK from cold.[10] It can be estimated that every year more than 200,000 people die from excess heat in Europe.[11] It is reasonable to estimate that each year about 1.5 million people die from excess cold in Europe.[12] This is more than seven times the total number of heat deaths.[13] Just in this millennium Europe have lost more than 10 million people to the cold, 300 times the iconic 35,000 heat deaths from 2003. That we so easily forget these deaths and so easily embrace the exclusive worry about global warming tells us of a breakdown in our sense of proportion.

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[6] (Ereaut & Segnit, 2006:7).
[7] http://www.climatecrisis.net/aboutthefilm/, accessed on March 17 2007.
[8] (Ebi, Mills, Smith, & Grambsch, 2006), see also (Basu & Samet, 2002; McMichael, Woodruff, & Hales, 2006) which *only* talks about heat related deaths.
[9] E.g. (Gore & Melcher Media, 2006:74-75).
[10] (BBC Annon., 2006)
[11] 207,000; based on a simple average of the available cold and heat deaths per million, cautiously excluding London from (Keatinge et al., 2000:672), and using WHO's estimate for Europe's population at 878m (WHO, 2004:121).
[12] 1.48 million estimated in the same way as total heat deaths.
[13] It is about 15% of the total death toll from Europe, (9.56m deaths, (WHO, 2004:121)).

The important fact, of course, is what will happen with future temperature increases. Let us for the moment assume – very unrealistically – that we will not adapt to towards the future heat. Still, the largest European study conclude that for at least for 2°C, "Our data suggest that any increases in mortality due to increased temperatures would be outweighed by much larger short term declines in cold related mortalities."[14] For Britain it is estimated that a 2°C increase will mean 2,000 more heat deaths but 20,000 fewer cold deaths.[15] A paper trying to incorporate all studies on this issue (a so-called meta-study) and apply it to a broad variety of settings both developed and developing around the world found that "global warming may cause a decrease in mortality rates, especially of cardiovascular diseases."[16] For the US, the net *lower* death count from global warming in 2050 is estimated at 174,000 per year.[17]

Sea level rise

In its 2007 report, the UN estimate that sea levels will rise about 34.5cm over the rest of the century.[18] While this is not a trivial amount, it is also important to realize that it is certainly not outside the historical experience. Since 1850 we have experienced a sea level rise of about 29cm, yet this has clearly not caused major disruptions. Sea level rise is a problem, but not a catastrophe. Ask a very old person about the most important issues that took place in the 20th century. She will likely mention the two world wars, the cold war, the internal combustion engine and perhaps the IT revolution. But it is very unlikely that she will add: 'oh, and sea levels rose.'

It is also important to realize that new prediction is *lower* than the previous IPCC estimates. The new span is 18-59cm (midpoint 38.5cm), down from 9-88cm in 2001 (midpoint 48.5cm).[19] This continues a declining trend from the nineties (where the first IPCC expected 67 cm), and the 80s, where the US EPA projected several meters.[20]

But this information is much less troublesome than what we often hear from global warming advocates. Al Gore has perhaps made their point most forcefully in his book and film. In a very moving film clip he shows us how large parts of Florida, including all of Miami, will be inundated by 20 feet of water.[21] He goes on to show us equally strong clips of San Francisco Bay being flooded, the Netherlands being wiped off the map, Beijing and then Shanghai being submerged, Bangladesh be made uninhabitable for 60 million people, and even how New York and its World Trade Center Memorial will be deluged.

How is it possible that one of today's strongest voices on climate change can say something so dramatically different from the best science, as we see from the IPCC in Figure 2. The IPCC estimates a foot, Gore tops them 20 times. Well, technically, Al Gore is not contradicting the UN, because he simply says: "If Greenland melted or broke up and slipped into the sea – or if half of Greenland and half of Antarctica melted or broke up and slipped into the sea, sea levels worldwide

[14] (Keatinge et al., 2000:672)
[15] (Keatinge & Donaldson, 2004:1096), (Langford & Bentham, 1995) likewise estimate 9000 fewer cold deaths.
[16] (W. J. M. Martens, 1998:342).
[17] (Bosello, Roson, & Tol, 2006).
[18] (IPCC, 2007b:10.6.5) says 29cm. A1B midpoint is 34.5cm (IPCC, 2007a).
[19] (IPCC, 2001:75).
[20] 1996: 38-55cm (IPCC & Houghton, 1996:364), 1992 and 1983 EPA from (Yohe & Neumann, 1997:243, 250).
[21] (Gore, 2006:59min ff; Gore & Melcher Media, 2006:196-209).

would increase by between 18 and 20 feet."[22] He is simply positing a hypothetical and then in full graphic and gory detail showing us what – hypothetically – would happen to Miami, San Francisco, Amsterdam, Beijing, Shanghai, Dhaka and then New York.[23]

But of course, the impact of the film clearly suggest immediate inundation, reinforced by such comments as rising sea levels around Beijing would mean that "more than 20 million people would have to be evacuated."[24]

Yet, take an overview of the simulations of Greenland sea level contributions.[25] None are higher than 3mm/year by the end of the century, whereas Gore's claim – if valid even in a century span – would have to be around 120mm or 40 times higher than the very highest model estimate. The IPCC estimate that Greenland is expected to contribute 3.5 cm over the century by itself, and with models indicating a lower estimate of 1cm and high estimate of 15cm.[26] This means that Gore's claim is 174 times higher than the IPCC, see Figure 2. It is unlikely that such an approach will lead to good policy initiatives.

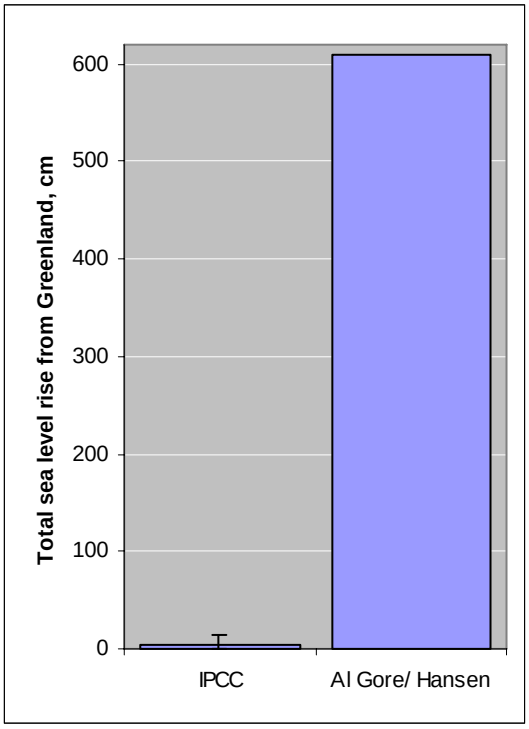

Figure 2 The estimate of Al Gore/Hansen of 21st century sea level rise due to Greenland melt. The IPCC estimate is 3.5cm, and uncertainty is indicated by the lowest (1cm) and highest (15cm) estimates from all available models. Al Gore and Hansen expect 609cm, or 174 times more.

[22] (Gore & Melcher Media, 2006:196)
[23] Yet, he also says: "First of all, this is not the worst case. The worst case, you don't want to hear! I think I'm right down the middle and in fact, the scientific community has validated the science in this film, and, for example, the six metre, six to seven metre sea level rise – that would come if Greenland broke up and slipped into the sea. It would come if west Antarctica, the portion that's propped up against the tops of islands with the warmer sea coming underneath it, if it went. If both went, it would be 12 to 14 metres" (Denton, 2006).
[24] (Gore & Melcher Media, 2006:204).
[25] (Gregory & Huybrechts, 2006:1721).
[26] (Gregory & Huybrechts, 2006:1721; IPCC, 2007b:10.6.4).

Hurricanes

Stronger and more frequent hurricanes have become one of the standard exhibits of the global warming worries. The solution offered is invariably CO_2 cuts and Kyoto.

With the strong 2005 hurricane season and the devastation of New Orleans by Katrina, this message has reverberated even more powerfully. Al Gore spends 26 pages on showing pictures of the suffering from New Orleans and names every single hurricane in 2005.

So has global warming caused stronger and more frequent hurricanes, and what will happen in the future? Let us here use the latest consensus statement from the UN World Meteorological Organization (parent organization for the IPCC), which is more recent and more specific but generally in agreement with the 2007 IPCC report.[27] It makes three strong and specific points.

> 1. Though there is evidence both for and against the existence of a detectable anthropogenic [human-caused] signal in the tropical cyclone climate record to date, no firm conclusion can be made on this point.[28]

They basically tell us that the strong statements of humans causing more and stronger hurricanes (or tropical cyclones as researches call them) are simply not well supported. We just don't know as of yet. When Al Gore tells us that there is a "scientific consensus that global warming is making hurricanes more powerful and more destructive" it is incorrect.[29]

> 2. No individual tropical cyclone can be directly attributed to climate change.

The strong statements on hurricane Katrina are simply not supportable.

This brings us to the third and perhaps most important WMO consensus point. In reality, we don't really care about hurricanes as such – what we care about is their damage. Do they end up killing people and cause widespread disruption? And with global warming, will they kill and disrupt even more? The answer is – perhaps surprisingly – that the whole hurricane debate is somewhat tangential to this important question.

> 3. The recent increase in societal impact from tropical cyclones has largely been caused by rising concentrations of population and infrastructure in coastal regions.[30]

The top part of Figure 3 clearly show us that the US cost of hurricane damage has increased relentlessly over the past century, and it seems to provide ample underpinning for Gore's "unmistakable economic impact of global warming." Yet, just comparing costs over long periods of time does not make sense without taking into account the change in population patterns and demography as well as economic prosperity. There are many more people, residing in much more vulnerable areas, with many more assets to lose. In the US today, the two coastal South Florida counties, Dade and Broward, are home to more people than the number of people who lived in 1930

[27] (WMO-IWTC, 2006a, , 2006b; WMO, 2006). This was concluded in December 2006, whereas the material deadline for IPCC is early/earlier 2006.
[28] (WMO-IWTC, 2006b).
[29] (Gore & Melcher Media, 2006:92)
[30] (WMO-IWTC, 2006b)

in *all* 109 coastal counties stretching from Texas through Virginia, along the Gulf and Atlantic coasts.[31]

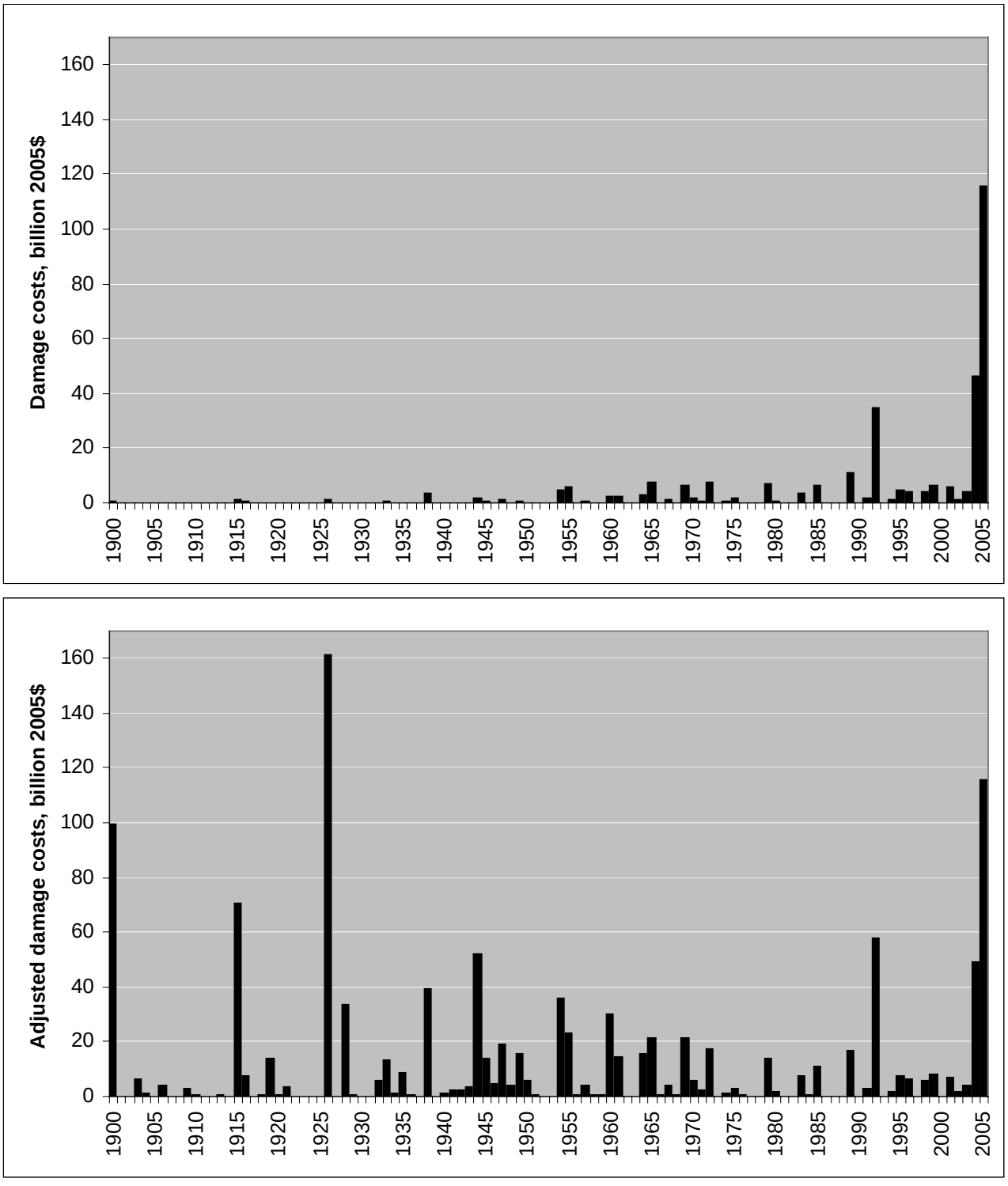

Figure 3 US hurricane damage, 1900-2005. Top panel shows the actual economic cost in 2005$, lower panel shows the cost, if the hurricanes had hit today. Damage for 1900-1925 is underestimated and more uncertain due to poor data availability.[32]

[31] (R. A. Pielke & Landsea, 1998).

In the top of Figure 3 we see the damage costs for rising through the century. Essentially no costs before mid-century, and just three years close to the present standing out. Here Katrina makes up two-thirds of the 2005 season costs, Charley and Ivan makes up most of 2004 and hurricane Andrew is responsible for almost all of 1992. It looks like a slam-dunk for climate-makes-badder-hurricanes.

But look what happens if you assume that all hurricanes would have hit the US as it is today, as can be seen in the lower part of Figure 3. Suddenly, the picture change dramatically. If the 1926 Great Miami hurricane had hit today it would have created the worst damage ever in the US hurricane history. What this tells us is that damages will continue to grow as long as more people with more stuff move closer to the sea.

We have to ask what it is we want. Presumably our goal is not to cut CO_2 emissions per se, but to do good for humans and the environment. We want to help the people who are potential victims of future Katrinas, Charleys and Andrews. But how can we best do that?

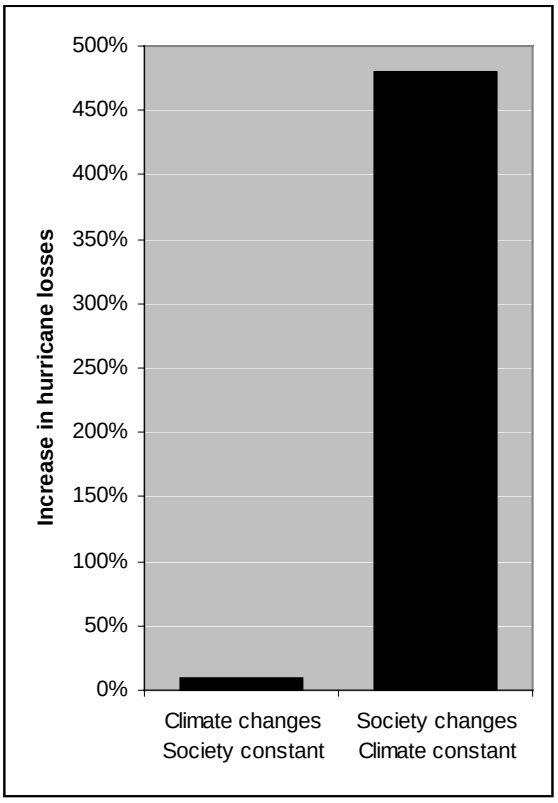

Figure 4 The relative importance of climate changes and social changes in hurricane damages from 2000-2050.[33]

In Figure 4 we see the relative impact of climate changes and social changes on hurricane damages over the next half-century. It essentially tells us the efficiency of turning the big knob of climate versus the efficiency of turning the social policy knobs.

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[32] (R. A. Pielke & Landsea, 1998; R. A. Jr. Pielke, 2006; R. A. Jr. Pielke et al., 2007), using PL normalization.
[33] (R. A. Pielke, 2005; Roger A. Jr. Pielke, Klein, & Sarewitz, 2000), an average of the three very similar climate increases and the A1 scenaro social increase.

If society stays the same – no more people living close to the coast, no more costly and densely built neighborhoods – and climate warms causing somewhat stronger hurricanes, the total effect will be less than a 10% increase in hurricane damages. To put it differently, if we could stop the climatic factors right now, we would avoid 10% more damage in 50 years time.

On the other hand, if climate stays the same – no more warming – but more people build more and more expensive buildings closer to the sea, as they have done in the past, we will see an almost 500% increase in hurricane damages. To put it differently, if we could curb societal factors right now, we could prevent 500% more damage in 50 years time.

So if we want to make a difference, which knob should we choose first – the one reducing damage by less than 10% or the one reducing damage by almost 500%? The difference in efficiency between the climate knob and the societal knob is more than 50 times.

> This seems to suggest that policies addressing societal factors rather than climate policies will do the much more good first.

Malaria

Al Gore writes: "Mosquitoes are profoundly affected by global warming. There are cities that were originally located just above the mosquito line, which used to mark the altitude above which mosquitoes would not venture. Nairobi, Kenya, and Harare, Zimbabwe, are two such cities. Now, with global warming, the mosquitoes are climbing to higher altitudes."[34]

Yet WHO and researches have documented that malaria epidemics happened in Nairobi many times between WWI and the 1950s.[35] The town's first medical officer, Dr. D.E. Boedeker, wrote that even for the early ivory and slave caravans, Nairobi "had always been regarded as an unhealthy locality swarming with mosquitoes."[36]

Like most stories there is at core some truth to the claim that malaria will increase with temperature, but it is a small part compared to richness and health infrastructure.

How much does global warming matters to malaria. One way to get an upper limit on the importance of global warming is to look at the projections of populations at risk. These models show an extra almost 300 million people will be living in areas that could harbor malaria in the 2080s because increasing temperatures expand the area where the parasite can multiply.[37] These models also tell us what will happen *without* climate change. Here, they project an increase from 4.4 billion in 1990 to 8.8 billion people at risk in 2085.[38] The total population at risk will thus be 9.1 billion out of a population of 10.7 billion.

But notice the proportions. 8.8 billion will be at risk from malaria in 2085 due to social factors, whereas 0.3 billion will be at risk due to global warming. Thus, even if we could entirely stop

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[34] (Gore & Melcher Media, 2006:173)
[35] (Hay, Guerra, Tatem, Atkinson, & Snow, 2005; Nakaji et al., 2004; Snow, Ikoku, Omumbo, & Ouma, 1999).
[36] (Reiter, 2007).
[37] (Arnell et al., 2002; P. Martens et al., 1999; van Lieshout, Kovats, Livermore, & Martens, 2004). Arnell finds 289.5m as average between unmitigated scenarios. We here use Arnell, since he is the only one to publish population at risk without climate, but he stays within the same framework and range of outcomes as the other referred articles.
[38] (Arnell et al., 2002:439).

global warming today (which we can't) we would only change malaria risk in 2085 by 3.2%.[39] More realistically, with the Kyoto Protocol, including the US and Australia, and committing everyone to constant emissions throughout the rest of the century, would reduce malaria risk by 0.2% in 80 years.[40] As the model team tells us: with a stringent climate policy "there is little clear effect even by the 2080s."[41]

Compare this to current expectations that we can cut malaria incidence to about half to three-foruths by 2015 for about $3 billion annually – or 2% of the cost of Kyoto.[42] This was the number 4 priority in the Copenhagen Consensus. Because we can do this within a decade whereas climate policy will take half a century or more, the difference in actual people helped is even more dramatic. Till 2085 Kyoto will avoid about 70 million people from getting infected by malaria (or about 0.1% of all malaria infections). Compare that to a simple and cheap halving of malaria incidence by 2015, which will avoid more than 28 billion people suffering from malaria.[43] This policy will do about 400 times more good, as is illustrated in Figure 5.

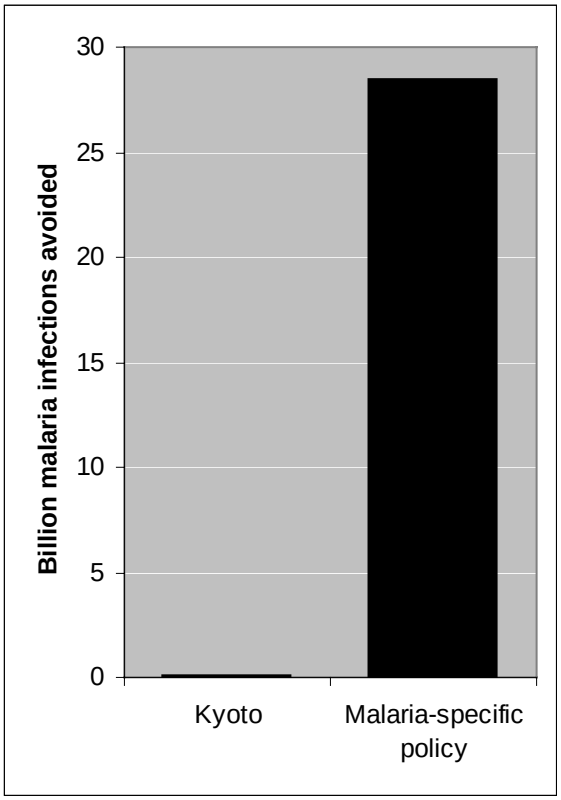

Figure 5 The number of people saved from malaria infects till 2085, by a full Kyoto policy and a policy to establish the Millennium Goal of halving malaria by 2015.[44]

[39] 289.5m/9109.5m.
[40] 289.5m/9109.5m * 7% (Wigley, 1998:2287).
[41] Speaking of 550ppm stabilization, (Arnell et al., 2002:440)
[42] (Awash & UN Millennium Project. Working Group on Malaria., 2005; Mills & Shillcutt, 2004:84-5).
[43] Calculated from 500 million actual annual malaria cases in 2000 and proportional from there with (Arnell et al., 2002:439).
[44] Based on (Arnell et al., 2002:439).

Smarter policies

The current raft of policies that are either enacted or suggested are costly but have virtually no effect.

Take the Kyoto Protocol, which even if it had been successfully adopted by all signatories (including the US and Australia) and even if it had been adhered to throughout the century, would have postponed warming by just 5 years in 2100 at a cost of $180 billion annually, see Figure 6.[45]

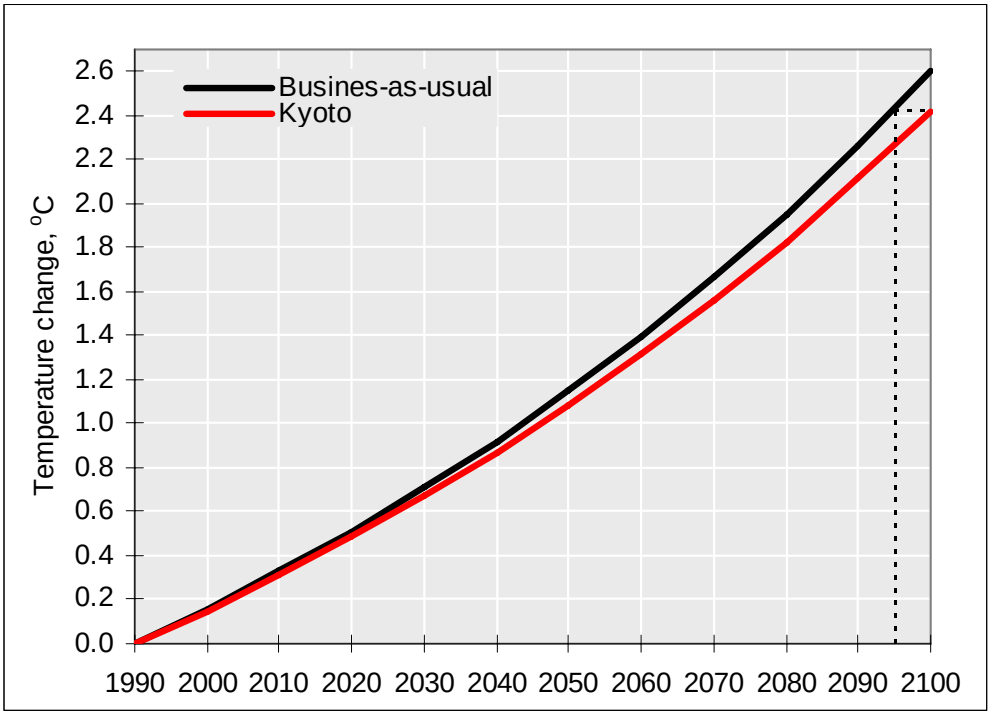

Figure 6 The expected increase in temperature with business-as-usual and with the Kyoto restrictions extended forever. Broken line shows the temperature for the business-as-usual scenario in 2095 is the same as the Kyoto temperature in 2100 (2.42°C).[46]

In the first real commitment since Kyoto in 1997, the EU announced in March 2007 that they would unilaterally cut emissions to 20% below 1990-levels by 2020.[47] This would mean a 25% cut of emissions from what they would otherwise have been in 2020.[48] Yet the effect on temperature would be smaller than Kyoto, as shown in Figure 7, postponing warming by the end of the century by about two years. The cost would be about $90 billion per year in 2020.[49] Thus, we see the same pattern from both the well-established Kyoto protocol and the new EU minus-20% decision – that they have fairly small impact at fairly high cost.

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[45] Cost average of all macroeconomic models with full Annex I trade, (Weyant & Hill, 1999).
[46] Based on (Wigley, 1998). He does runs for climate sensitivity of 1.5, 2.5 and 4.5°C, showing that they in all cases change about 7%. Thus, the graph here is adjusted for the IPCC middle scenario of 2.6°C.
[47] (EU, 2007c:12). Notice, that promising such goal is not reaching it. In the same EU document, EU actually starts out lauding the accomplishments of its Lisbon Strategy from 2000, "aimed at making the European Union the most competitive economy in the world" (EU, 2007b). A central target here is achieving 3% of GDP R&D. Yet, a recent LSE assessment shows that the target "will not be achieved by 2010"(CEP, 2006). Actually, while the EU average for R&D in 2000 was 1.86, the latest figures from 2005 have *declined* to 1.84% (for EU-27, for EU-15 it went from 1.92% to 1.91%) (EU, 2007a).
[48] (IEA, 2006:507).
[49] Estimated with (Nordhaus, 2006a).

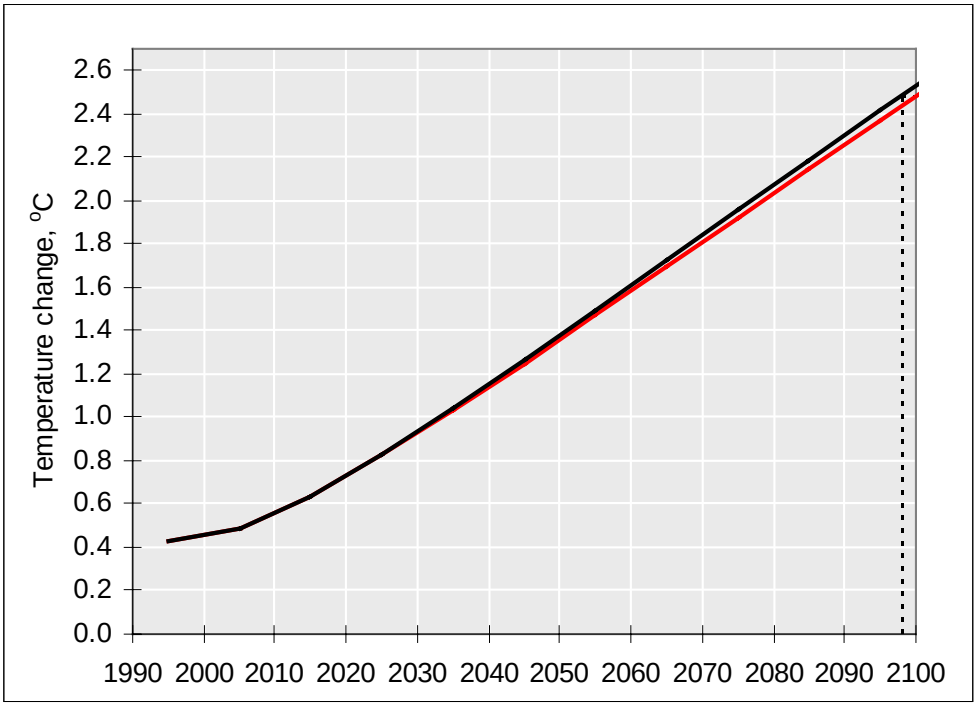

Figure 7 The expected increase in temperature with business-as-usual and with the EU minus-20% restrictions extended forever. Broken line shows the temperature for the business-as-usual scenario in 2098 is the same as the reduced temperature in 2100 (2.48°C).[50]

This is also the case for Al Gore's public commitment to tackle global warming. In his recent speech to New York University, he explicitly said that he would eliminate payroll taxes and substitute them with pollution taxes, principally a CO_2 tax.[51] Yet he never actually say how much this would cost or how much good it would do.

If one calculates the impact of such a promise, it shows that payroll taxes (social security) in the US amounted to $841 billion in 2006.[52] With the US emitting about 6Gt of CO_2 this means a tax of $140/t$CO_2$, and a tax on gas at about $1.25 per gallon.[53] In one respected model, the annual economic cost amounts to about $160 billion for the US economy in 2015. This would cut emissions to about half in 2015 and about 25% in 2105.[54] Yet, since the US will make up an ever smaller amount of the total CO_2 emitted throughout the century, the total effect in 2100 will be a reduction of global temperature by 0.1°C (see Figure 8).[55] Essentially, what Al Gore is suggesting is that the US carries through a Kyoto-type restriction all by itself.

[50] Estimated with (Nordhaus, 2006a).
[51] (Gore, 2006).
[52] (USCB, 2006).
[53] Extrapolation to 2006 from (EIA, 2006).
[54] Using (Nordhaus, 2006a), compared to business as usual.
[55] From 2.52°C to 2.43°C.

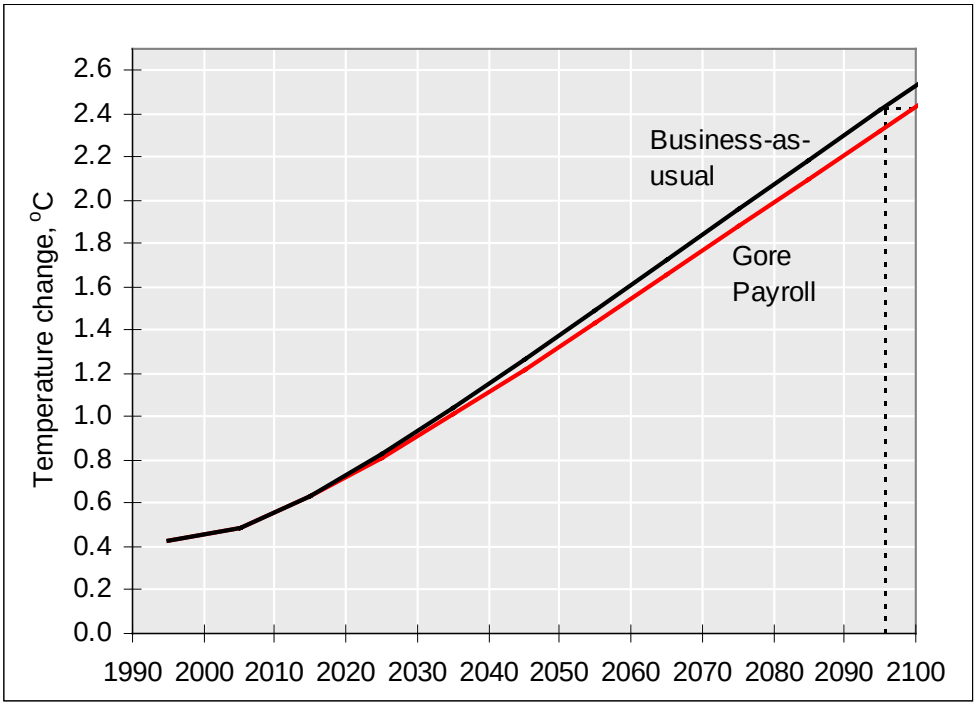

Figure 8 The expected increase in temperature with business-as-usual and with Al Gore's suggestion to replace payroll tax with a fixed carbon tax of $140/ton of CO_2, extended forever. Broken line shows the temperature for the business-as-usual scenario in 2095.5 is the same as the reduced temperature in 2100 (2.43°C).[56]

This is why the major peer-reviewed economic cost-benefit analyses show that climate change is real, and that we should do something but our cuts should be rather small. In the latest review the previous research is summarized:

> "These studies recommend that greenhouse gas emissions be reduced below business-as-usual forecasts, but the reductions suggested have been modest."[57]

This was the state of the art economics till October 2006, when a 600-page UK government report under economist Sir Nicholas Stern came out and created headlines everywhere.[58]

Virtually everyone have come away with the understanding that Stern has made a cost-benefit analysis and shown that the benefit (avoided cost of global warming) is 20% and the cost just 1% making strong climate action a slam-dunk.[59]

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[56] Estimated with (Nordhaus, 2006a).
[57] (Stern, 2006:298). This is similar to the conclusion from a meeting of all economic modelers: "Current assessments determine that the 'optimal' policy calls for a relatively modest level of control of CO_2" (Nordhaus, 1998:18)
[58] E.g. (Gibbon, 2006; Stern, 2006; Timmons, 2006). The UK UN counsellor said worldwide attention has gone "beyond the wildest expectations" of the UK government (Hagen, 2007).
[59] Even Prime Minister Tony Blair: "Stern shows that if we fail to act, the cost of tackling the disruption to people and economies would cost at least five per cent - and possible as much as 20% - of the world's output. In contrast, the cost of action to halt and reverse climate change would cost just 1%. Or put another way for every £1 we invest now, we can save at least £5 and possibly much more"(Blair, 2006).

Yet, a raft of academic papers have now come out, all strongly criticizing Stern, liberally using words as "substandard," "preposterous," "incompetent," "deeply flawed," and "neither balanced nor credible."[60] While there is a long list of problems with the analysis, I will just point out two issues.

1. The damages from climate change (the benefits of action) are vastly inflated. As several peer-reviewed papers point out, "the Stern Review does not present new data, or even a new model."[61] How can it then find conclusions that are completely outside the usual range? It turns out that the Review has counted damages several times, and somewhat arbitrarily increase the damages 8-fold or more according to new and conjectural cost categories that have never been peer reviewed.[62] At the same time, the review has decided to change a key parameter in all cost-benefit analyses to a value that gives huge damage.[63] Oddly, it forgets to use this parameter for the costs below, where it would count against a strong policy response.[64] The parameter is also vastly out of sync with our present-day behavior: it would suggest that we should today save 97.5% of our GDP for future generations.[65] This is patently absurd – today's saving rate is about 15% in the UK.

2. The costs of action are vastly underestimated, continuing a well-known 'appraisal optimism' which was also seen in the 1950s onwards in very low cost-estimates for nuclear power.[66] Again, it finds itself on the edge of the state-of-the-art and simultaneously forgets to count any costs after 2050, although they presumably continue way into the 23rd century.[67]

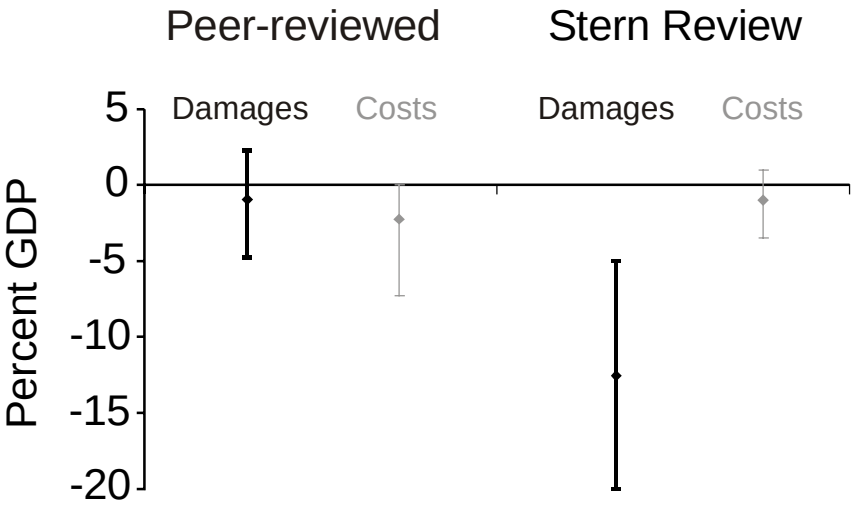

Figure 9 Comparison with the peer-reviewed state-of-the-art and the Stern review estimates of damage and costs.[68] As you can see, damages in peer-reviewed studies are not bad enough to warrant the costs of partially avoiding them. Stern swaps this argument around.

[60] (Byatt et al., 2006; Carter, de Freitas, Goklany, Holland, & Lindzen, 2006; Dasgupta, 2006; Nordhaus, 2006b; Tol, 2006; Tol & Yohe, 2006; Varian, 2006; Yohe, 2006).
[61] (Byatt et al., 2006:203; Tol & Yohe, 2006:235).
[62] (Byatt et al., 2006:204-5; Tol, 2006:979; Tol & Yohe, 2006:238)
[63] (Tol, 2006:979; Tol & Yohe, 2006:238).
[64] They simply stop counting the cost after 2050, while the cost escalates from 2.2% to 6.4% of GDP in 2100 (Tol & Yohe, 2006:239).
[65] (Dasgupta, 2006).
[66] (Byatt et al., 2006:206).
[67] (Tol & Yohe, 2006:239).
[68] (Tol & Yohe, 2006:235).

If you look at Figure 9 you see that Stern has essentially swapped the peer reviewed literature on costs and benefits, and that is why he get the opposite result of everyone else. The most well-known climate economist, Richard Nordhaus, concludes that the Stern review is "a political document."[69]

The Stern review must be praised for having put the economics squarely back into the climate debate. Whether or not we like to acknowledge it, doing something about global warming will have both costs and benefits, and we need the dialogue on how much we should do. But the Stern review does not change the fact that all peer reviewed economic analyses show we should only reduce CO_2 emissions moderately.[70]

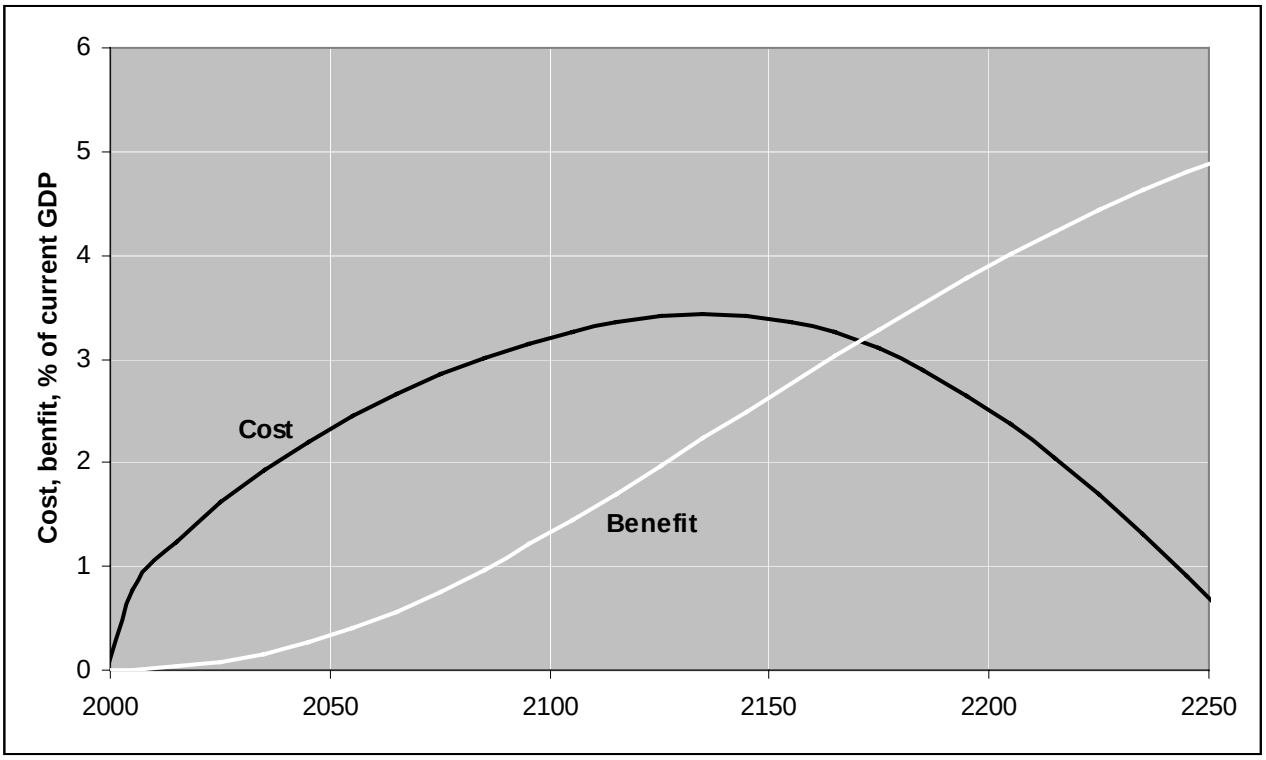

Figure 10 Cost and benefits over time of stabilizing at 1990 CO_2 levels.[71]

Why is this a robust result? If we look at costs and benefits over time in Figure 10 we see the reason. Essentially, the cost comes up front, whereas the benefit comes much further down the line. For the first 170 years the costs are greater than the benefits. Even when the benefits catch up in the late 22nd century, there is still a payback time before the total benefits outweigh the total costs around 2250. Thus, as one academic paper points out, "the costs associated with an emissions stabilization program are relatively large for current generations and continue to increase over the next 100 years. The first generation to actually benefit from the stabilization program is born early during the 24th century."[72]

[69] (Nordhaus, 2006b:5).
[70] (Stern, 2006:298). This is similar to the conclusion from a meeting of all economic modelers: "Current assessments determine that the 'optimal' policy calls for a relatively modest level of control of CO_2" (Nordhaus, 1998:18)
[71] (Nordhaus, 2006a)
[72] (Kavuncu & Knabb, 2005:369, 383).

This does not mean we should do nothing at all about climate change. It means we need to be much smarter. We need to abandon expensive and inefficient strategies like Kyoto and search for new opportunities.

Of course, part of us still want to say "let's do it all". And I agree. In an ideal world we would deal with all the world's woes. We should win the war against hunger, end conflicts, stop communicable diseases, provide clean drinking, step up education and halt climate change. But we don't. And so we have to start face reality.

When we realize that there are many areas in the world – like HIV, malnutrition, free trade, malaria, clean drinking water etc. – where we can do immense amounts of good, it seem obvious to me we must focus our attention and our big expenditure there first.

But it does not mean we shouldn't start thinking about how we can cheaply tackle climate change in the long run. The big problem about cutting carbon emissions Kyoto style is that it costs a lot now, and does very little for the future. Moreover, if we paid the bill for cutting emissions down to 1990-level this year, we will have to pay just as much (or even a little more) next year to cut it to the same level. That is a bad deal. And it also means that for the next hundred years, we will have to negotiate ever more excruciatingly costly treaties between 192 countries, many of them poor countries like China and India, hungry for more power. That is going to be hard. Or looking just at Kyoto, maybe more like impossible.

The trick probably lies in understanding that what matters is not whether we cut a little now, but whether we eventually cut a lot. So maybe we should try going a different way.

Right now we could get all the world's energy from solar cells taking up very little (and otherwise useless) space. The equivalent of 2.6% of the area of the Sahara. Why don't we? Because it would be horrendously costly. But solar energy has come down in price about 50% per decade over the past 30 years. Even at a much lower pace, it will probably become competitive before mid-century for many uses, and before the end of the century for most uses. If we invested more in research and development (R&D) this development would probably go faster. Likely, such an investment would do much more good than Kyoto ever could, and be much cheaper.

And of course, solar power is but one – if very promising – opportunity. We have wind, that is already competitive some places, as in Denmark. We have carbon capture, fusion and fission, energy efficiency, biomass and biodiesel. It is hard to tell which will work best, but maybe we shouldn't. Maybe we should let nations search out these opportunities for the long-term benefit for the world.

My proposal for tackling global warming in the long run is that all nations commit themselves to spending 0.05% of GDP in R&D of non-carbon emitting energy technologies.[73] This approach

[73] The same kind of approach is built-in to the Asia-Pacific Partnership on Clean Development and Climate, which focuses on energy efficiency and diffusion of advanced technologies in electricity, transport and key industry sectors. Because it focuses on some of this century's biggest emitters, including China, India and the US, it is forecast to reduce global carbon emissions with 11% in 2050 (Fisher et al., 2006) – for reference, a full Kyoto would only reduce emissions by 9% in 2050. The cost, however, is unclear at the moment. It is seen as cheap and voluntary, but it is doubtful that entirely voluntary measures will achieve all of the AP6 potential. And certainly, in the long run, more smart measures will be needed.

would cost about $25 billion per year, seven times cheaper than Kyoto and many more times cheaper than a Kyoto II. It would involve all nations, with richer nations naturally paying the larger share. It would let each country focus on its own future vision of energy needs, whether that means concentrating on renewable sources, nuclear energy, fusion, carbon storage, or searching for new and more exotic opportunities.

Such a massive global research effort would also have potentially huge innovation spin-offs (a bit like NASA's going to the moon also gave us computers and velcro). Because the costs are low and there will be many immediate innovation benefits, countries do not have to be ever more strongly cajoled into ever more restrictive agreements. They will partake because it involves them in a strong, science-based endeavor. They will partake, because it is a smart thing to do.

And most importantly, it will likely have a much greater impact on the long-term climate.

Global warming only one of many issues

Global warming is not the only issue we need to tackle. This especially holds true for the third world. It is obvious that there are many other and more pressing issues for the third world, such as almost 4 million dying from malnutrition (underweight), 3 million from HIV/AIDS (unsafe sex), 2.5 million from indoor and outdoor air pollution, more than 2 million from lack of micronutrients (iron, zinc and vitamin A) and almost 2 million from lack of clean drinking water.[74]

Even if global warming exacerbates some or more of these problems, it is important to point out that the total magnitude of the problems is likely to far exceed the contribution from climate change. Thus, polices to reduce the total problems will have much more leverage than policies that only try to address the global warming part of the issues.[75] Again, we have to ask if there are better ways to help than by cutting CO_2.

We have to ask ourselves: what do we want to do first? Do we want to focus on cutting CO_2, at fairly high costs and doing fairly little good a hundred years from now? Or would we rather want to fix some of the many obvious problems in the world, where we could do a lot more good and do it now?

In the so-called Copenhagen Consensus process, we asked this general question to some of the smartest economists in the world: where would you spend extra resources to do good first?[76] Experts put forward their best solutions from climate change and communicable diseases, over conflicts, education, financial instability, governance & corruption, malnutrition and hunger, population: migration to sanitation & water and subsidies & trade barriers. But they didn't just say their proposals would do good – they said how much good they would do and how much they would cost.

A panel of top-level economists, including four Nobel Laureates then made the first explicit global priority list ever, shown in Table 1. It divided the world's opportunities into very good, good, and fair according to how much more good they would do for each dollar spent, and bad opportunities where each dollar would do less than a dollar worth of good.

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[74] (WHO, 2002:224).
[75] (Goklany, 2006:322).
[76] (Lomborg, 2004, , 2006). You can see more at www.copenhagenconsensus.com.

		Challenge	Opportunity
Very Good Opportunities	1	Diseases	Control of HIV/AIDS
	2	Malnutrition	Providing micro nutrients
	3	Subsidies and Trade	Trade liberalisation
	4	Diseases	Control of malaria
Good Opportunities	5	Malnutrition	Development of new agricultural technologies
	6	Sanitation & Water	Small-scale water technology for livelihoods
	7	Sanitation & Water	Community-managed water supply and sanitation
	8	Sanitation & Water	Research on water productivity in food production
	9	Government	Lowering the cost of starting a new business
Fair Opportunities	10	Migration	Lowering barriers to migration for skilled workers
	11	Malnutrition	Improving infant and child nutrition
	12	Malnutrition	Reducing the prevalence of low birth weight
	13	Diseases	Scaled-up basic health services
Bad Opportunities	14	Migration	Guest worker programmes for the unskilled
	15	Climate	Optimal carbon tax ($25-300)
	16	Climate	The Kyoto Protocol
	17	Climate	Value-at-risk carbon tax ($100-450)

Table 1 Global priority list from Copenhagen Consensus, 2004.[77]

Preventing HIV/AIDS turns out to be the very best investment humanity can make – for each dollar it spends saving lives it will do about forty dollars worth of social good. For $27 billion, we can save 28 million lives over the coming years.[78]

Malnutrition kills almost 2.4 million lives each year. Perhaps even more dramatically, it affects more than half the world's population, by damaging eyesight, lowering IQ, reducing development and restricting human productivity. Investing $12 billion could probably half the incidence and death rate, with each dollar doing more than 30 dollars worth of social good.[79]

Ending first world agricultural subsidies and ensuring free trade would make almost everyone much better off. Models suggest that benefits of up to $2,400 billion annually would be achievable, which half of that benefit accruing to the third world. In achieving this, it would be necessary to bribe first world farmers, but the benefits of each dollar used would do more than fifteen dollars worth of social good.

Finally, malaria kills more than a million each year. It infects about two billion people each year (many several times) and causes widespread debilitation. Yet, an investment of $13 billion could cut incidence by half, protect 90% of newborns, and cut deaths of under-5s by 72%.[80]

At the other end of the spectrum, the Nobels placed climate change opportunities, including Kyoto at the bottom under the heading 'bad opportunities', underlining what we saw above, namely that for each dollar spent, we would end up doing much less than a dollar worth of good for the world.

[77] (Lomborg, 2004:606).
[78] (Lomborg, 2004:104).
[79] (Lomborg, 2004:404-5)
[80] (Lomborg, 2004:109; , 2006:26-27).

But the Copenhagen Consensus did not just ask top economists. We asked 80 young college students from all over the world, with 70% from developing countries, with equal gender representation, and from arts, sciences and social sciences. After five days independently inquiring the experts in all the areas, they came to a surprisingly similar result as the Nobels. The placed malnutrition and communicable diseases on top, climate change next to last.[81]

In 2006 we asked a wide range of UN ambassadors to make their priority list after two days of intensive debates. Besides the three biggest countries China, India and the US, countries as diverse as Angola, Australia, and Azerbaijan participated, along with Canada, Chile, Egypt, Iraq, Mexico, Nigeria, Poland, South Korea, Somalia, Tanzania, Vietnam, Zimbabwe and many others. They came out with a quite similar list, placing communicable diseases, clean drinking water and malnutrition at top, with climate change towards the bottom.[82]

This should make us stop and pause. None of these forums have said that climate change is not real or not important. But they ask us to consider, whether we would do better by addressing the real and pressing needs of current generations that we can solve so easily and cheaply, before we try to tackle the long-term problem of climate change where we can do so little for so much.

To put it very bluntly, the Kyoto Protocol would likely cost at least $180 billion a year and do little good. UNICEF estimates that just $70-80 billion a year could give all Third World inhabitants access to the basics like health, education, water and sanitation.[83] More important still is the fact that if we could muster such a massive investment in the present-day developing countries this would also give them a much better future position in terms of resources and infrastructure from which to manage a future global warming. What would we rather do first?

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[81] (Lomborg, 2004:647)
[82] (Copenhagen Consensus, 2006), Kyoto is number 23, and the other proposals 37-40 of 40.
[83] (UNICEF, 2000:37).

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